Naval Research Laboratory

Stennis Space Center, MS 39529-5004

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NRL Glider Data Report for the Shelf-Slope Experiment

Joel Wesson
Jeffrey W. Book
Sherwin Ladner
Andrew Quaid
Ian Martens

Ocean Sciences Branch
Oceanography Division

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14. ABSTRACT
Data report from SLOCUM glider deployments in the Gulf of Mexico Mississippi Bight region, as part of the 2015-2016 Shelf-Slope Experiment: "Shelf-Slope Interactions and Carbon Transformation and Transport in the Northern Gulf of Mexico: Platform Proof of Concept for the Ocean Observing System in the Northern Gulf of Mexico," conducted under a NOAA funded grant to the University of Southern Mississippi. The main successful deployment period was from 11 February, 2016 until 16 February, 2016. The glider made a total of 349 survey profiles within the geographical box bounded between 28.95N to 29.25N and 88.6W to 88.25W. The report includes glider locations, CTD data plots, Optical sensor data plots, and a listing of data files used, included for further analysis.

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Oceanography — Glider survey

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Table of Contents

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August, 2016

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The NRL Slocum glider SL083 was deployed for the Shelf-Slope experiment: "Shelf-Slope Interactions and Carbon Transformation and Transport in the Northern Gulf of Mexico: Platform Proof of Concept for the Ocean Observing System in the Northern Gulf of Mexico", on 11 February 2016 near 29.3 deg N, 88.45 deg W. It operated until mid-day Feb 16, 2016 and returned 339 profiles. This followed previous unsuccessful glider deployment attempts on Nov 6, and Dec 1, 2015, and a deployment on Jan 29 near 28.95 deg N, 88.75 degW that made 10 profiles but only 1 profile to 50m and two profiles to 190m depth. The glider deployed in November had a software malfunction, the glider deployed in December had a serious leak, and the glider deployed in January 2016 was retrieved after it began aborting dives due to software errors. The location of the Jan 29 deployment profiles is shown in Figure 3.

Data was processed using the LAGER processing system (NRL Technical Memo MR7330-10-9247). The system automatically processes both transmitted files (sbd/tbd files) in real time, and full sized files (ebd/dbd files) downloaded after recovery. The sbd/tbd files contain only a subset of all the variables being recorded, and their data is decimated for transmission over IRIDIUM, while the ebd/dbd files are complete. Output netcdf files (.nc files) from the LAGER processing refer only to tbd and ebd original files, so sbd and dbd will be dropped in the subsequent text.

The output files from the LAGER system have been run through automatic quality control (QC) processing to remove spikes and bad data, for both the CTD and optical sensor data products. The conditions under which the QC processing changes CTD data are: 1) When the CTD is unpumped, corrections are made for thermal lag. 2) Gravitationally unstable CTD profiles are made stable. QC data flags are generated for spikes and for large deviations from the US Navy's Generalized Digital Environmental Model (GDEM) climatology profiles. Optics QC generates flags to indicate that manual examination of profiles is required. Both corrected and uncorrected data are included in the output editman.nc NetCDF files, which are the outputs from this processing. Original data is also preserved in producing the QC output variables. The primary dataset used for plots and analysis is the complete *editman.nc files generated from the ebd files.

Files needed for the LAGER processing are configuration and calibration files included as separate archives: SETUP files: Areas, lager_info.dat

sensor_config: sl083_sensorconfig.dat

calibration files: ctd_sl083.dat, bamslk_BAMSLK-006G.dat, fl3slo_FL3SLO-1033.dat, bb3slo_BB3SLO-271.dat

Manuscript approved August 14, 2017.

The primary scientific data recorded during profiling yo-yos are: Temperature, Salinity, Pressure, CDOM, BB(backscatter) at 470, 532 and 660 um, Chlorophyll, and Phycoerytherin.
The Phycoerytherin signal appears to be simply noise. Time/depth images for all the scientific data channels are shown in attached plots. The Oxygen sensor (Optode) produced no data except for zero at the surface. The Bam-C sensor only functioned correctly during the two day January deployment. Bam-C data were produced for February, but values are erroneous.

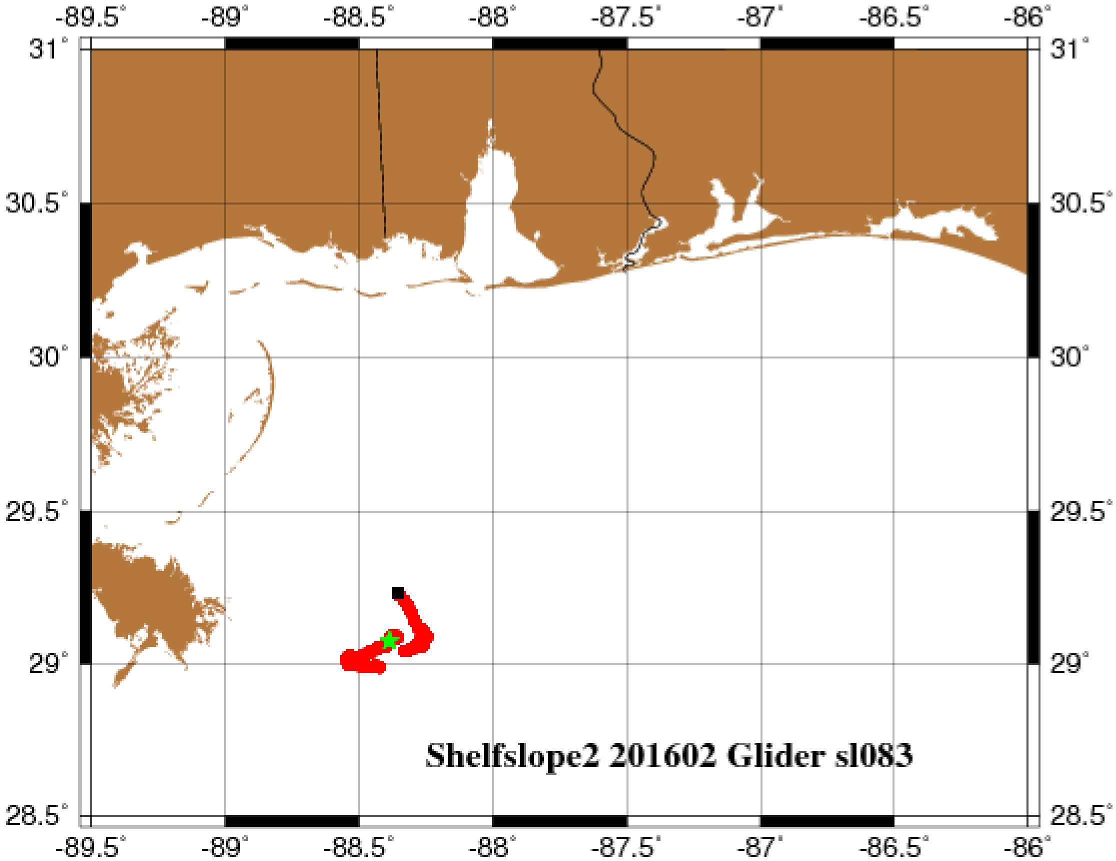

Figure 1. Glider Locations Large scale map. The green star was the recovered/final location. Black is for deployment location.

Glider locations
Locations and times (shown by varying color) are illustrated in Figures 1, 2, and 3.

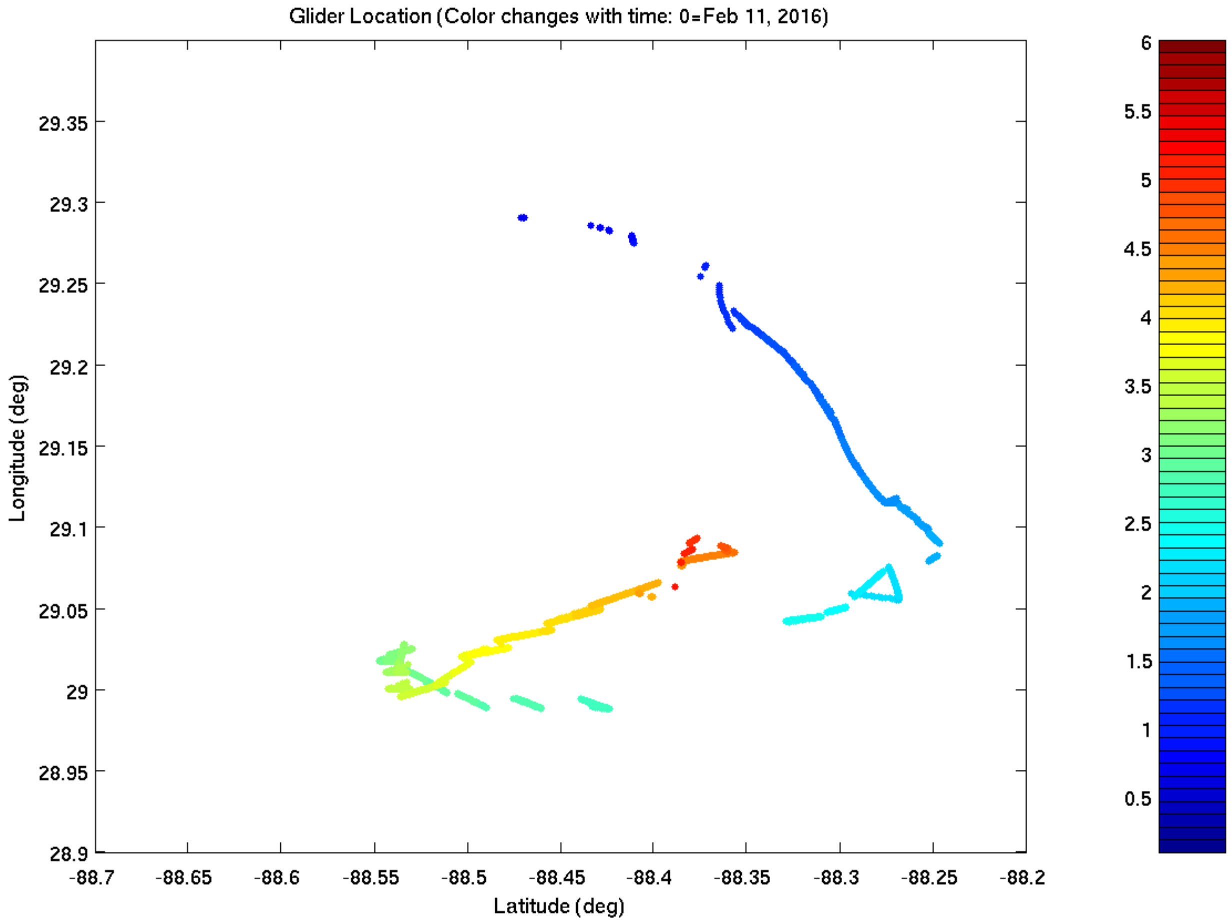

Figure 2. Glider profile locations, small scale map. Dots indicate the location of profiles which are shown in further figures. Times when the glider was on the surface are not shown. Color variation is over decimal days from 0-6 where 0 corresponds to 11 Feb 2016.

The following figure shows the Jan 29 deployment profile locations.

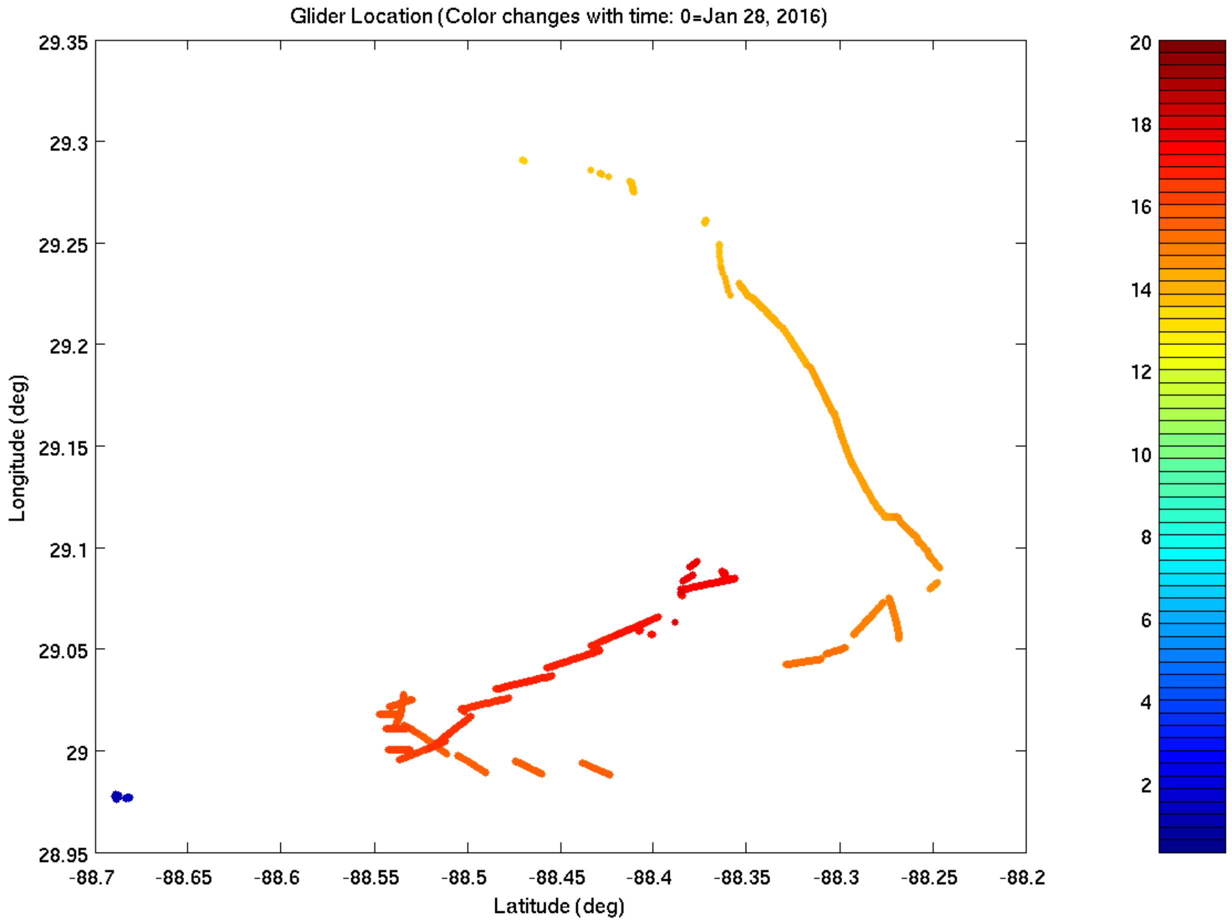

Figure 3. Location map with early deployment profiles. The Jan 29 profiles are dark blue in the southwest corner. The color bar varies by decimal days in the figure. Their range is from 0-20, with 0 corresponding to 28 Jan 2016.

The next two figures show Temperature waterfall image plots. The first, Figure 4, is expanded for the primary data deployment time, while Figure 5 includes the profiles from the January 29 deployment period for completeness.

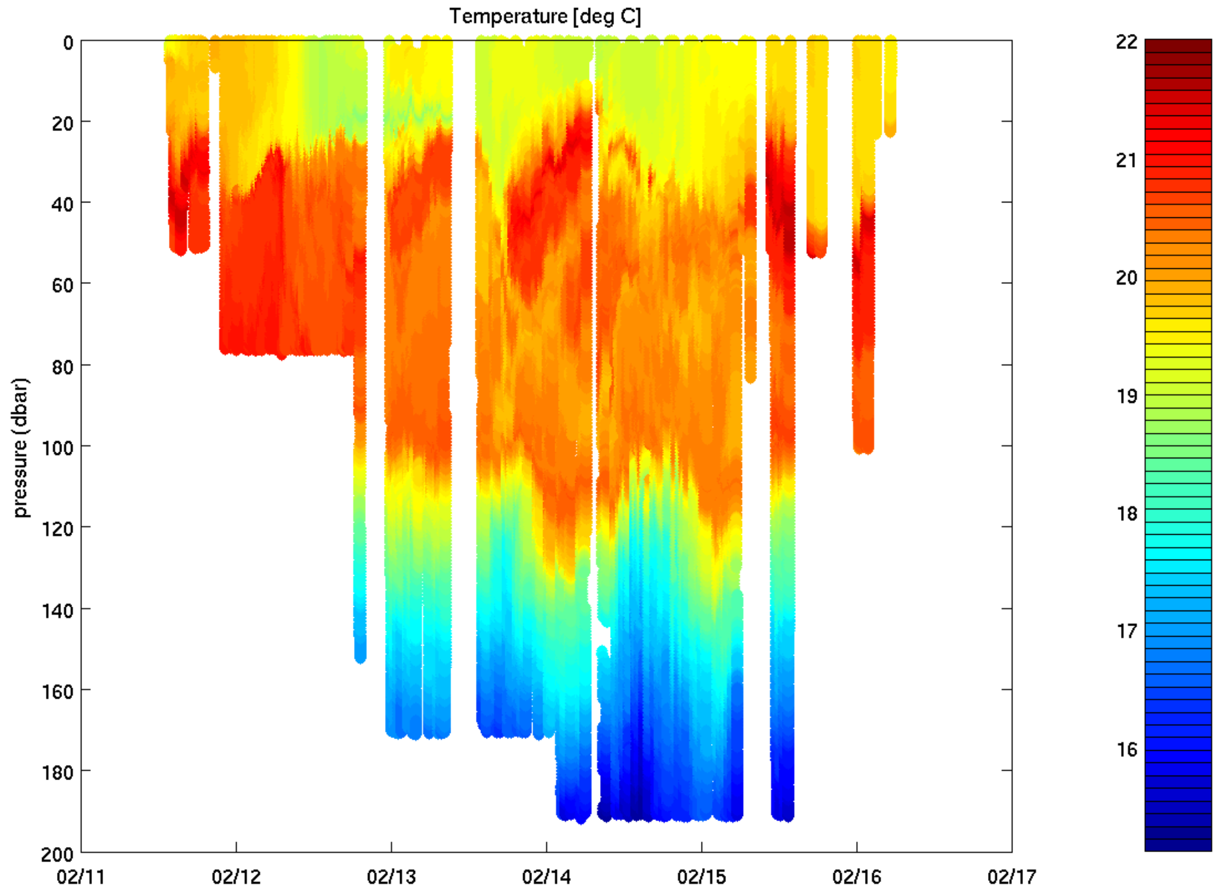

Figure 4. Temperature waterfall image plot for the main deployment period.

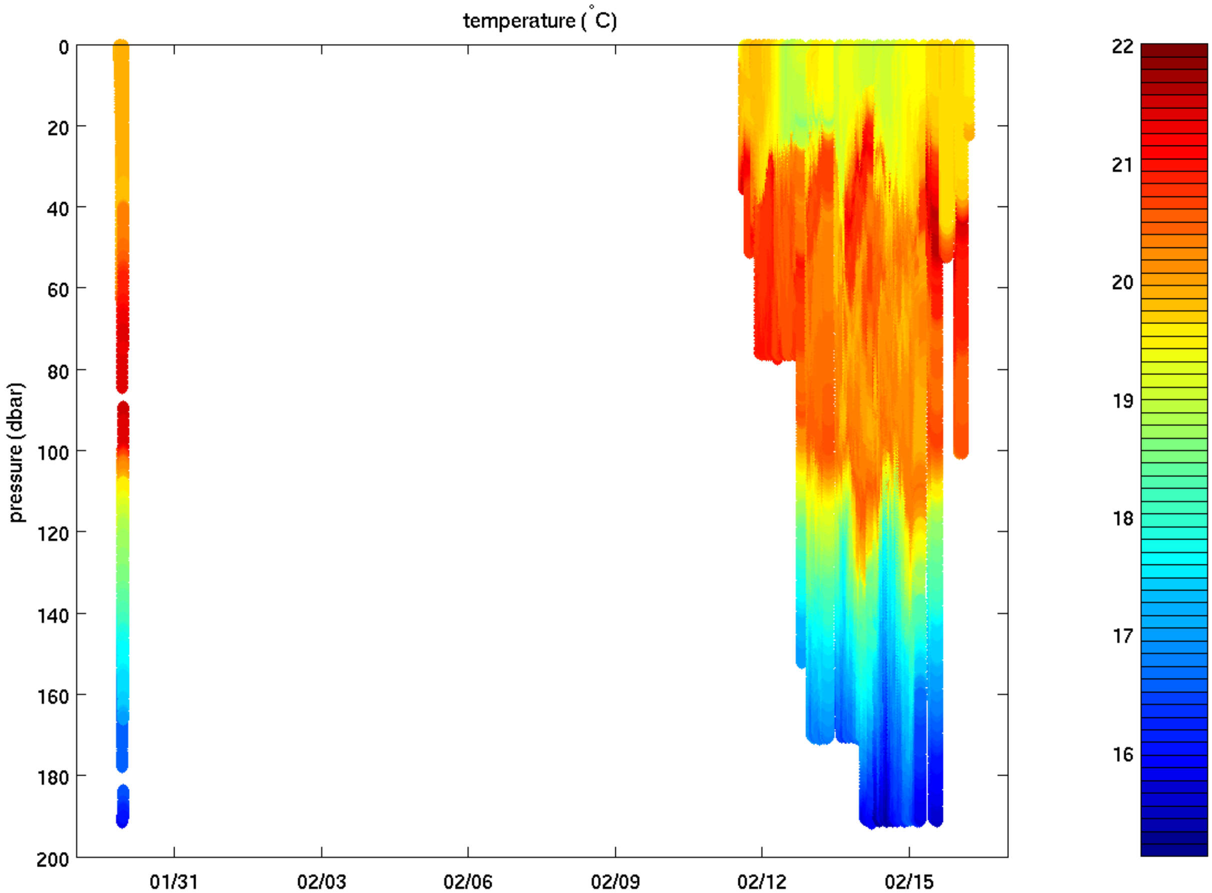

Figure 5. Temperature waterfall plot with Jan 29 profiles.

Other scientific products:

Salinity and Optical products from the Glider Science bay data.

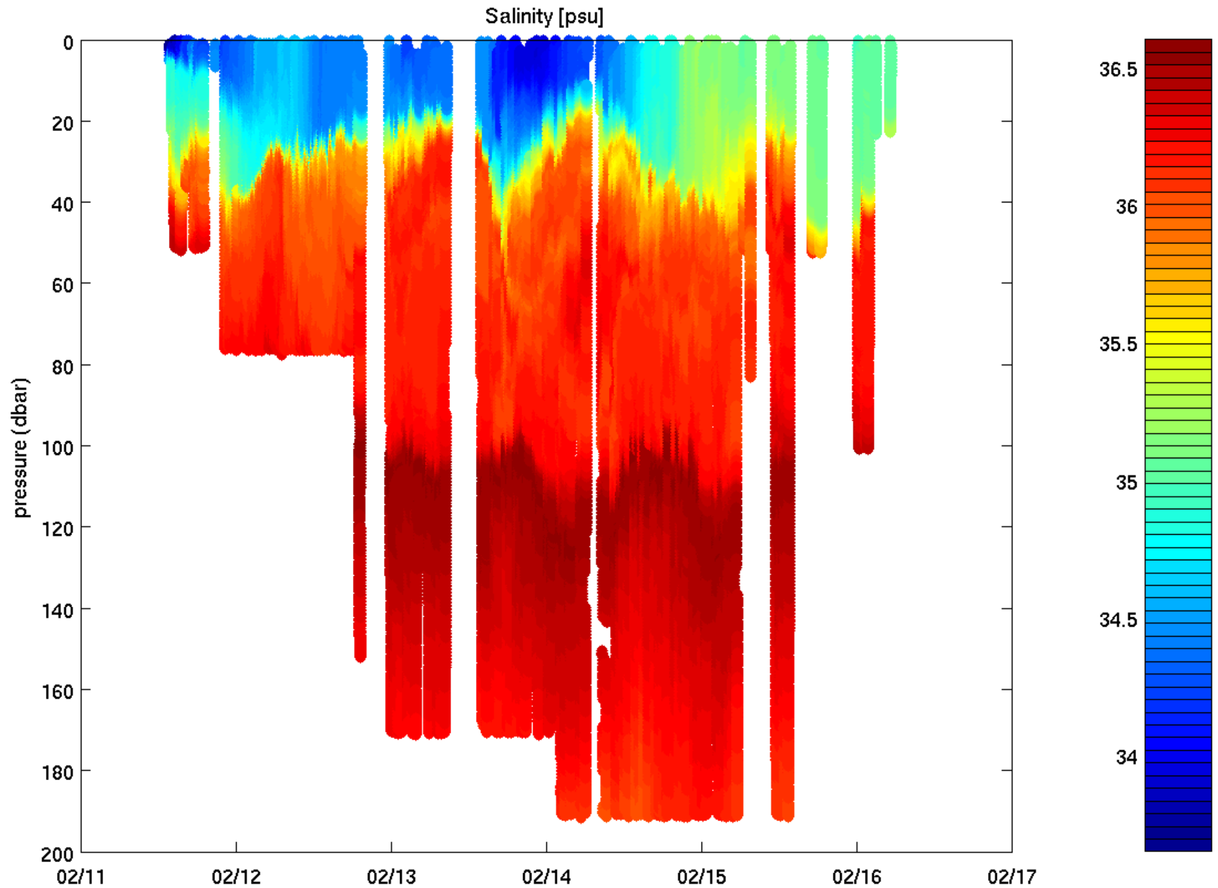

Figure 6. Salinity Waterfall image plot.

Optical Properties.
The optics sensors were turned off on Feb 15, so there is less data from them than for Temperature and Salinity. The images from all of the optical properties are consistent, and show similar water body characteristics, with the exception of Phycoeritherin, which appears to be simply noise.

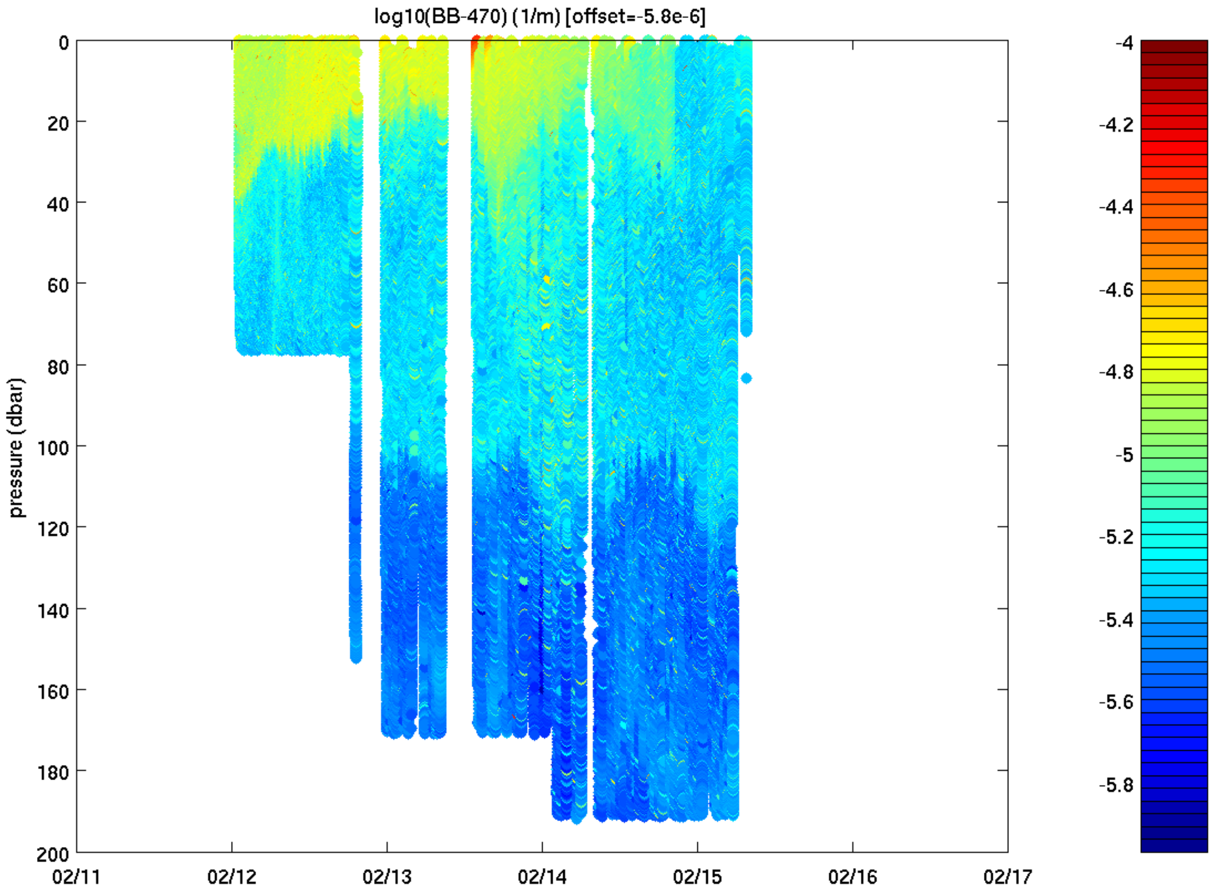

Figure 7. BB-470 Backscatter waterfall image.

All of the backscatter, as well as the CDOM and Chlorophyll plots, look similar.
In all cases of the optical property data products, in the scaled data from LAGER processing there were small negative values, presumably due to the application of a slightly faulty calibration. This data was re-zeroed with an offset value for each plot, since there were many values around this minimum value. In the title of each plot, the offset used (I.e the value reset to be zero) is included. The data in the editman.nc files is unchanged, so in further plotting the offset (or a different offset to re-zero the data) will have to be applied.

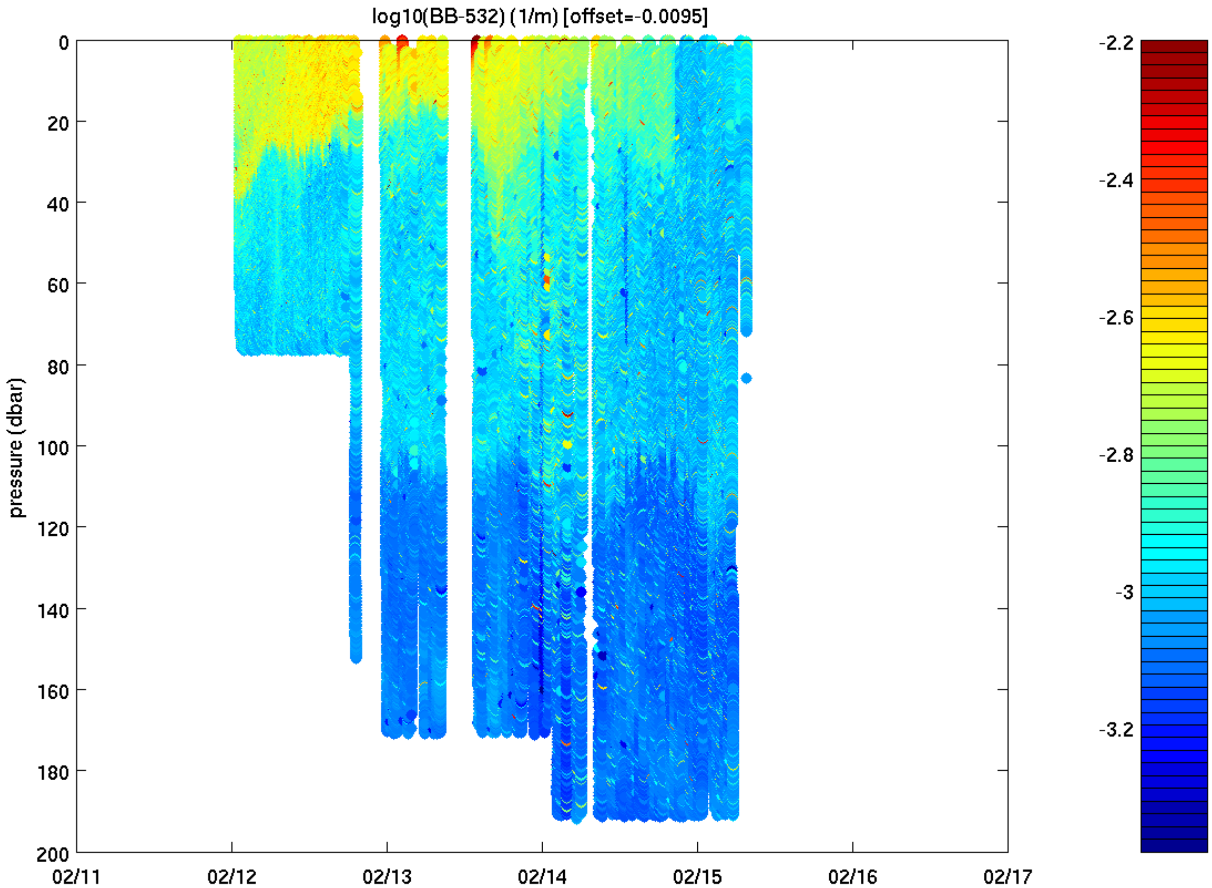

Figure 8. BB-532 backscatter waterfall image plot.

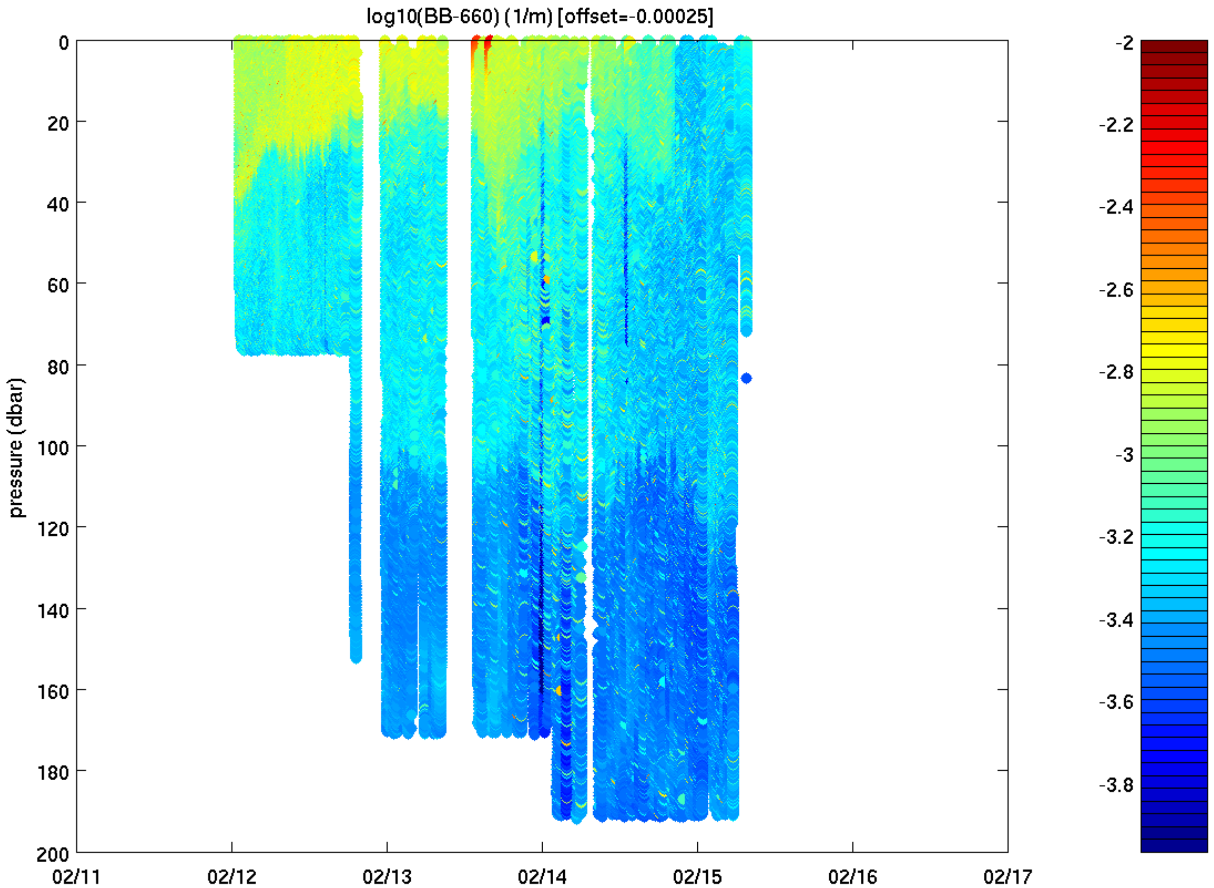

Figure 9. BB-660 waterfall image plot.

The other optical property plots:

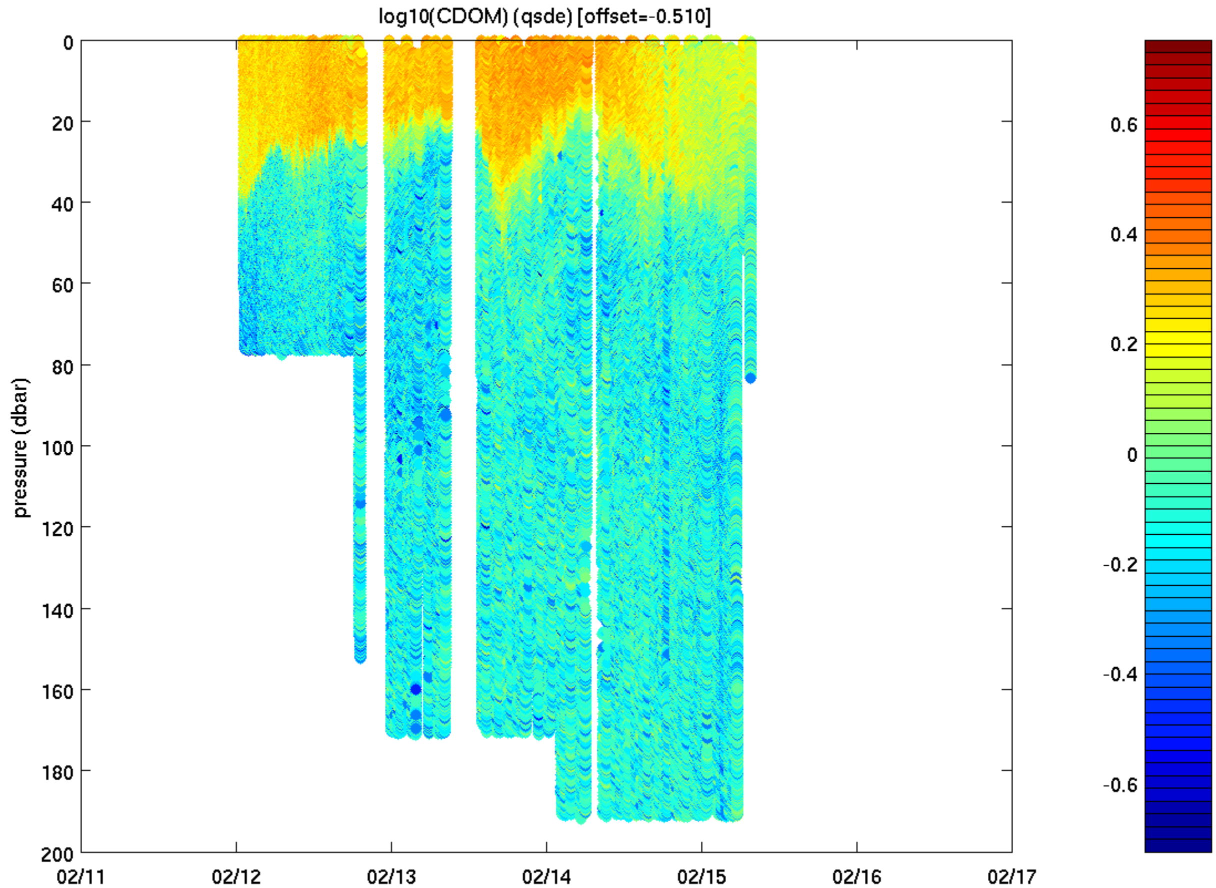

Figure 10. CDOM waterfall image plot. Log scale.

The CDOM signal does correspond well with the water mass changes of the Temperature and Salinity images.

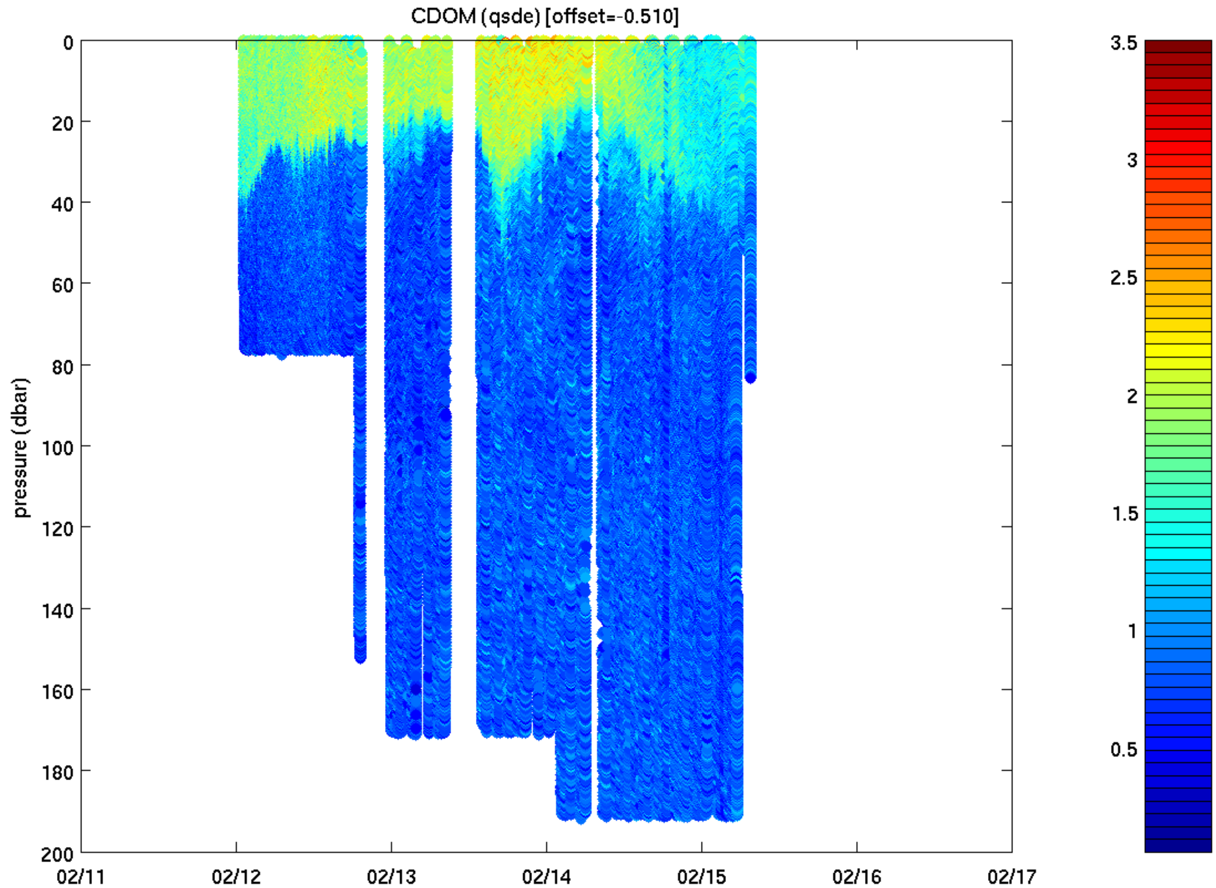

Figure 11. CDOM waterfall image plot. Linear plot.

Chlorophyll shows a similar water mass picture as CDOM. But there is secondary structure in it below ~30m depth that does not appear in the CDOM.

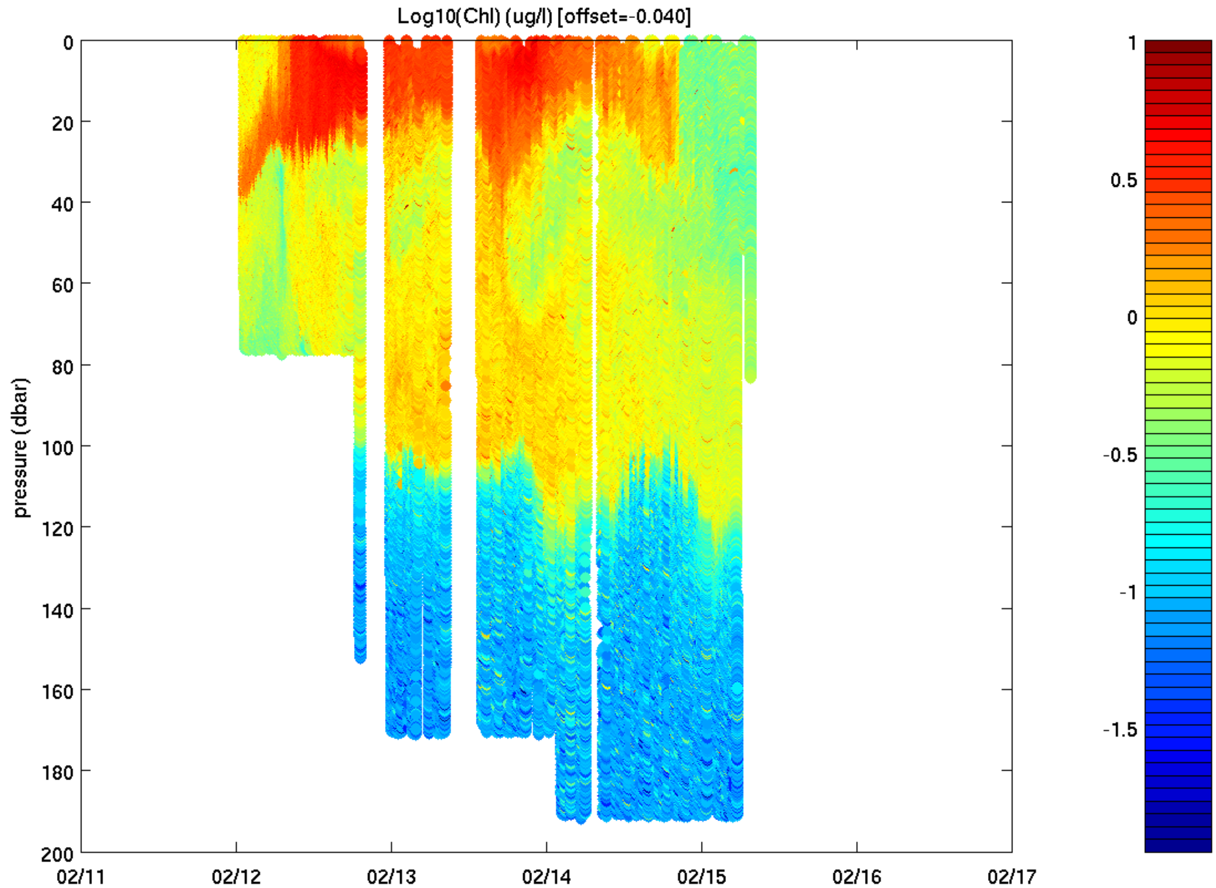

Figure 12. Chlorophyll waterfall image plot. Log scale.

The low Chlorophyll region at the surface at the end of the survey corresponds to when Salinity increased, probably in water less affected by Mississippi outflow.

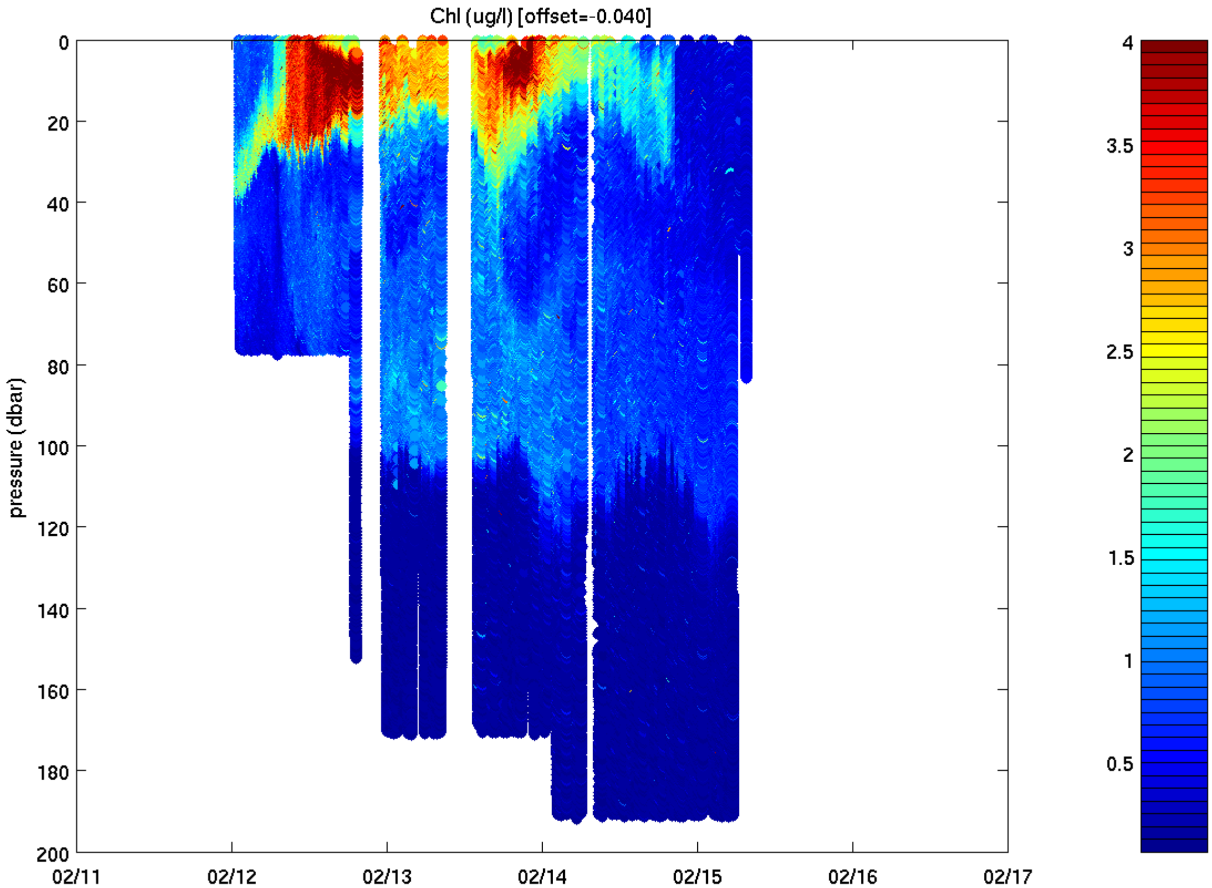

Figure 13. Chlorophyll waterfall image plot. Linear scale.

The phycoerytherin channel is included for completeness only. It does not appear to have any value for scientific analysis.

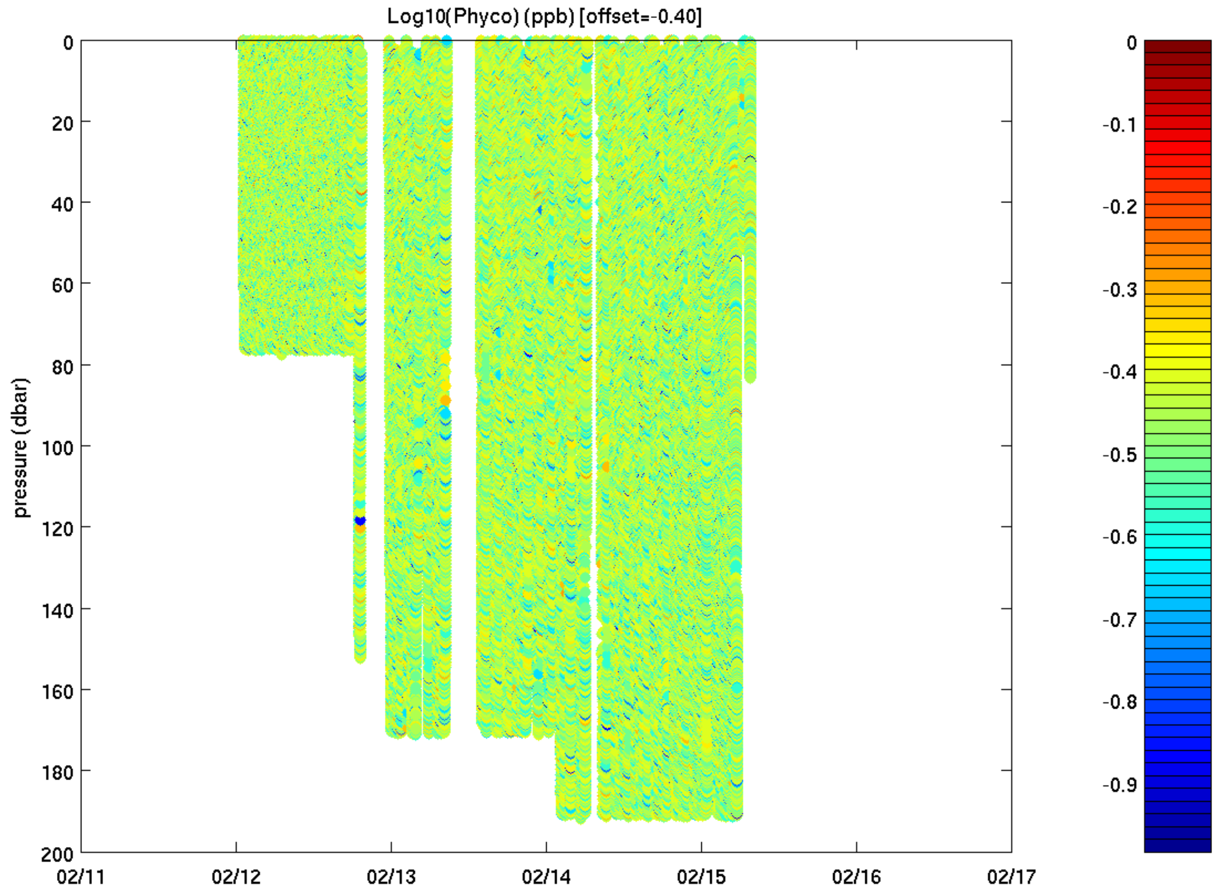

Figure 14. Phycoerytherin waterfall image plot.

This seems to be only noise in the signal. There is no correlation with water masses that is seen in the other optical property plots.

Temperature Salinity diagram (TS) plots:

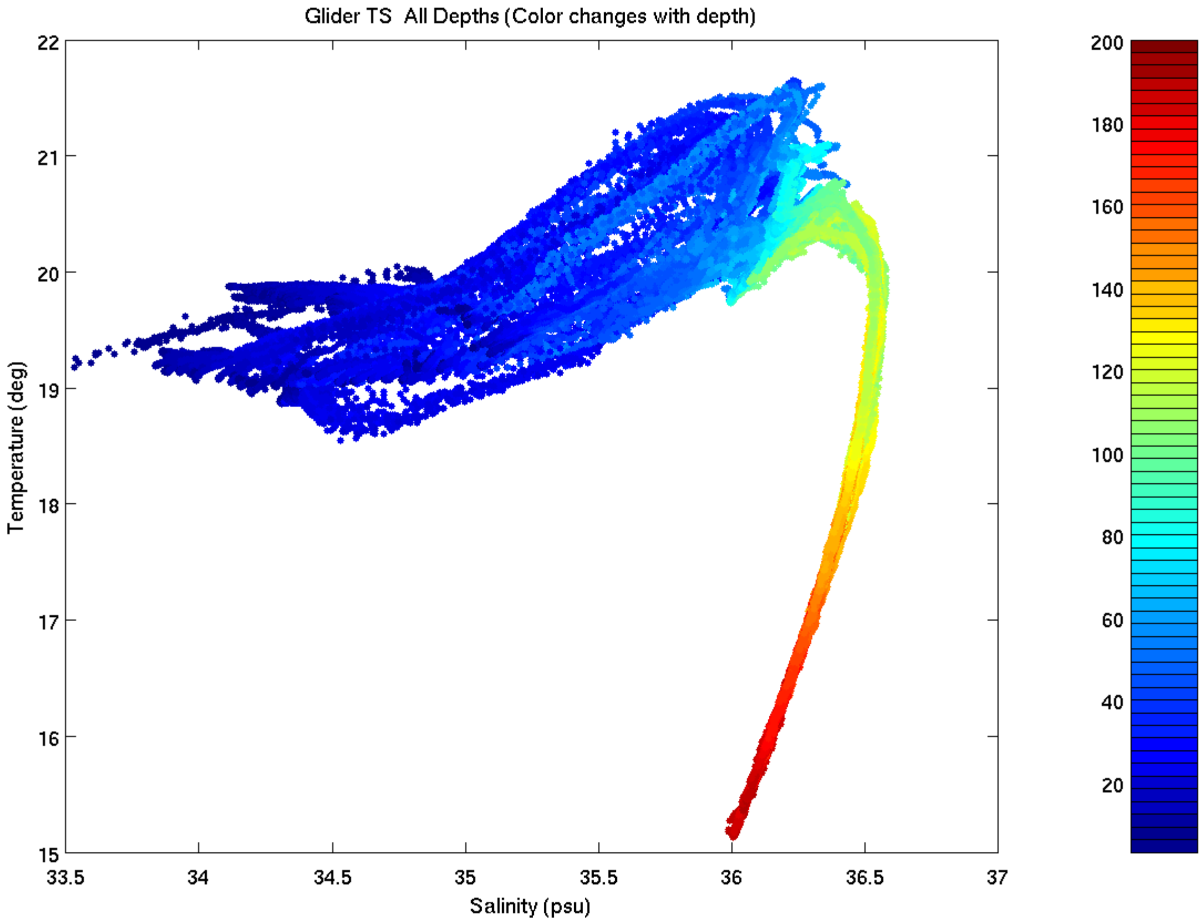

Figure 15. TS diagram all depths. Dot color corresponds to depth (0-200m) here.

In the following figure, the TS points from the glider profiles below 50m depth, are sorted using color variation by time.

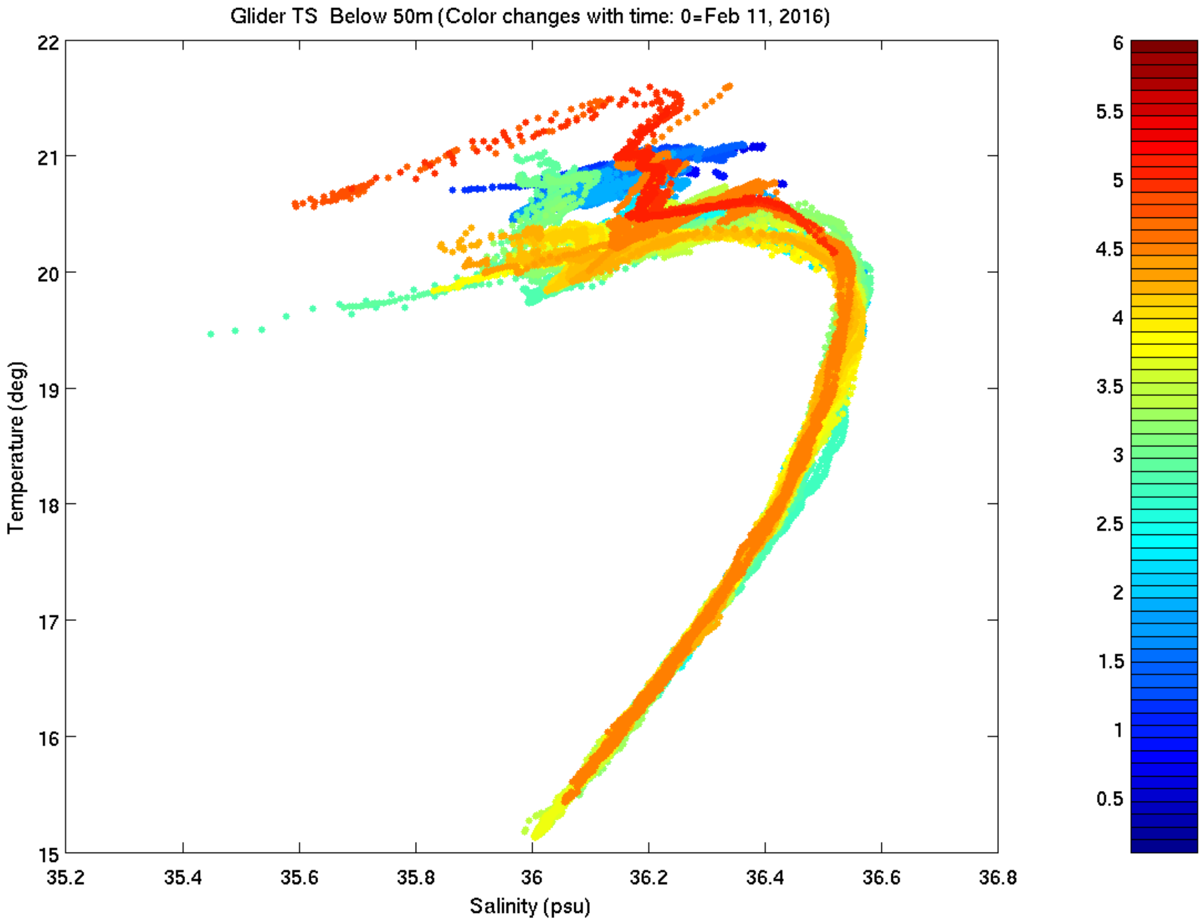

Figure 16. TS plot of deep water sorted by time. The time span is 6 days.

Files included with this report:

Editman.nc files from ebd files: 58 from the February Deployment
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The Table below of the editman.nc files includes the number of profiles in each file, where a down or up section of a yo-yo is one profile, and the maximum depth of the profiles in each file.

Table 1. File names, number of profiles, deepest profile.

File Name	Profiles	Max Depth(m)
sl083_2016_0129_2044_0886818W_289765N_00900000_editman.nc	2	4
sl083_2016_0129_2113_0886882W_289759N_01000000_editman.nc	2	3
sl083_2016_0129_2130_0886884W_289760N_01100000_editman.nc	2	10
sl083_2016_0129_2145_0886891W_289771N_01200000_editman.nc	2	51
sl083_2016_0129_2218_0886883W_289775N_01300000_editman.nc	1	191
sl083_2016_0129_2307_0886826W_289768N_01300100_editman.nc	1	191
sl083_2016_0211_1351_0884973W_292925N_00200000_editman.nc	2	5
sl083_2016_0211_1411_0884864W_292918N_00400000_editman.nc	2	22
sl083_2016_0211_1433_0884768W_292909N_00400200_editman.nc	2	51
sl083_2016_0211_1455_0884697W_292906N_00400400_editman.nc	2	36
sl083_2016_0211_1534_0884521W_292890N_00600000_editman.nc	2	52
sl083_2016_0211_1618_0884334W_292857N_00700000_editman.nc	2	36
sl083_2016_0211_1635_0884284W_292842N_00700100_editman.nc	2	36
sl083_2016_0211_1651_0884243W_292830N_00800000_editman.nc	2	33
sl083_2016_0211_1751_0884121W_292791N_00900000_editman.nc	10	51
sl083_2016_0211_1849_0884078W_292736N_01000000_editman.nc	8	51
sl083_2016_0211_2045_0883720W_292616N_01100000_editman.nc	1	7
sl083_2016_0211_2321_0883634W_292422N_01200000_editman.nc	16	76
sl083_2016_0212_0049_0883561W_292320N_01200100_editman.nc	4	76
sl083_2016_0212_0147_0883513W_292267N_01200200_editman.nc	8	78
sl083_2016_0212_0337_0883393W_292161N_00000000_editman.nc	16	77
sl083_2016_0212_0547_0883239W_291991N_00100000_editman.nc	16	76
sl083_2016_0212_0800_0883098W_291780N_00200000_editman.nc	16	76
sl083_2016_0212_1011_0882991W_291553N_00300000_editman.nc	18	76
sl083_2016_0212_1137_0882926W_291403N_00300100_editman.nc	4	76
sl083_2016_0212_1254_0882839W_291261N_00400000_editman.nc	14	77
sl083_2016_0212_1422_0882720W_291150N_00500000_editman.nc	6	76
sl083_2016_0212_1527_0882631W_291089N_00500100_editman.nc	8	76
sl083_2016_0212_1631_0882553W_291009N_00500200_editman.nc	6	77
sl083_2016_0212_1732_0882492W_290934N_00500300_editman.nc	8	76
sl083_2016_0212_1911_0882494W_290812N_00600000_editman.nc	2	152

File Name	Profiles	Max Depth(m)
sl083_2016_0213_0052_0882702W_290656N_00800000_editman.nc	8	171
sl083_2016_0213_0329_0882842W_290652N_00000000_editman.nc	8	171
sl083_2016_0213_0605_0883018W_290492N_00000200_editman.nc	4	171
sl083_2016_0213_0746_0883192W_290437N_00000400_editman.nc	6	171
sl083_2016_0213_1428_0884311W_289911N_00000800_editman.nc	4	171
sl083_2016_0213_1632_0884670W_289916N_00001000_editman.nc	4	171
sl083_2016_0213_1826_0884973W_289934N_00001200_editman.nc	6	171
sl083_2016_0213_2029_0885220W_290056N_00100000_editman.nc	8	171
sl083_2016_0213_2302_0885417W_290180N_00100200_editman.nc	4	171
sl083_2016_0214_0047_0885357W_290233N_00100400_editman.nc	6	168
sl083_2016_0214_0240_0885351W_290225N_00100600_editman.nc	4	191
sl083_2016_0214_0348_0885376W_290143N_00100800_editman.nc	2	191
sl083_2016_0214_0544_0885380W_290109N_00200000_editman.nc	4	191
sl083_2016_0214_0907_0885365W_290005N_00300000_editman.n	4	191
sl083_2016_0214_1149_0885240W_290000N_00300400_editman.nc	8	191
sl083_2016_0214_1451_0885075W_290102N_00300800_editman.nc	8	191
sl083_2016_0214_1627_0885013W_290190N_00301000_editman.n	2	17
sl083_2016_0214_1754_0884906W_290231N_00301200_editman.nc	8	191
sl083_2016_0214_1927_0884817W_290282N_00301400_editman.nc	1	3
sl083_2016_0214_2058_0884693W_290337N_00301600_editman.nc	8	191
sl083_2016_0214_2354_0884431W_290451N_00301800_editman.nc	8	191
sl083_2016_0215_0133_0884300W_290499N_00302000_editman.nc	2	50
sl083_2016_0215_0357_0884153W_290589N_00302300_editman.nc	12	191
sl083_2016_0215_0640_0884011W_290572N_00000000_editman.nc	2	52
sl083_2016_0215_0737_0884073W_290592N_00000300_editman.nc	1	85
sl083_2016_0215_1054_0883847W_290765N_00100000_editman.nc	2	52
sl083_2016_0215_1233_0883706W_290821N_00100200_editman.nc	8	191
sl083_2016_0215_1720_0883612W_290857N_00600000_editman.nc	4	52
sl083_2016_0215_1831_0883625W_290880N_00800000_editman.nc	4	52
sl083_2016_0216_0030_0883785W_290917N_00000000_editman.nc	4	100
sl083_2016_0216_0141_0883813W_290851N_00000200_editman.nc	4	100
sl083_2016_0216_0300_0883851W_290782N_00200000_editman.nc	2	23
sl083_2016_0216_0517_0883885W_290631N_00500000_editman.n	2	23

NETCDF Files From LAGER Processing

The NetCDF files have many variables not presented here, as well as those used in this report.
Variables from the editman.nc files used in this report:
scitime
temp
pressure
salinity
longitude
latitude
sci_fl3slo_phyco_units - phycoeritherin
sci_bb3slo_b470_scaled
sci_bb3slo_b532_scaled
sci_bb3slo_b660_scaled
sci_fl3slo_cdom_units
sci_fl3slo_chlor_units

prof_num, prof_start_index, and prof_end_index are used for finding specific profiles and their starts and ends.
Extensive other variables from the qc processing include:
numtbad – number of bad Temperatures
numsbad – number of bad Salinities
temp_flag for temperature flags,
salt_flag for salt flags,
as well as a complete set of qc flags for the optics variables.

Scientific variables not used in this report:
msci_oxy3835_oxygen – oxygen concentration, the only non-NaN oxygen values were zero at the ocean surface
sci_bbam_beam_s – beam C – only the Jan 29, 2016 deployment had Beam C values.

There are also '_orig' variables that are unchanged by any qc processing, e.g salinity_orig.
The detailed header (produced using ncdump or similar netcdf utility) provides variable units, names, missing_value, and description for each variable. There are also navigation dead-reckoning variables and depth-average current variables.

Table 2. Glider oceanographic instrument configuration.

January Deployment	February Deployment
CTD: 0092	CTD: 0086
BB3: 271	BB3: 271
FL3: 1033	FL3: 1033
BAM: 006G	BAM: 006G
Optode: 5013W_1401	Optode: 5013W_1401